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<b>(21) International Application Number:</b> PCT/NL96/00004 <b>(22) International Filing Date:</b> 2 January 1996 (02.01.96)  <b>(30) Priority Data:</b> 9500006                      2 January 1995 (02.01.95)                      NL  <b>(71) Applicant (for all designated States except US):</b> GASCOIGNE MELOTTE B.V. [NL/NL]; Gildenweg 2, P.O. Box 1068, NL-8300 BB Emmeloord (NL).  <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> LUBBERINK, Jan [NL/NL]; Tipakker 17, NL-7971 AB Havelte (NL).  <b>(74) Agent:</b> DE BRUIJN, Leendert, C.; Nederlandsch Octrooibu- reau, Scheveningseweg 82, P.O. Box 29720, NL-2502 LS The Hague (NL).		<b>(81) Designated States:</b> JP, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the</i> <i>claims and to be republished in the event of the receipt of</i> <i>amendments.</i> <i>In English translation (filed in Dutch).</i>
<b>(54) Title:</b> METHOD AND DEVICE FOR POSITIONING TEAT CUPS  <b>(57) Abstract</b>  Method and device for positioning teat cups on the teats of a milking animal, such as a cow. The position of the teats of the animal in question is recorded by one or more cameras, and said position is stored in a memory. In a subsequent milking operation said position is recorded again and compared with the first position stored in the memory. A correction is then made in such a way that the first observed position corresponds to the last observed position. A correction by the same amount is made in the position of the teat cups, so that the latter fit accurately on the teats of the animal in question.		

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# Method and device for positioning teat cups

The present invention relates to a method for positioning teat cups.

Such a method is used for the automatic positioning of teat  
5 cups on the teats of milking animals, such as milking cows.

In principle, two approaches are possible for providing adjustment of the positions of the teat cups and teats relative to each other.

In a first approach the teat cups are suspended in such a way  
10 that they move freely and are guided with or without the aid of a funnel-like construction through the teats of the milking animals. It has been found in practice that it is difficult to suspend the teat cups so freely that they can move easily, and it often occurs that the teats are not taken into the cups.

15 Another possibility is in one way or another to determine the position of the teats and subsequently to establish the position of the teat cups in a corresponding way.

One way of doing this is described in European Application  
A1-0,309,036.

20 In a currently known embodiment thereof the animal to be milked is fixed in a position by partitions which centre the animal in the breadthwise direction and a push-up partition which determines the position of the rear end of the animal.

The cluster with the teat cups is then initially placed by hand  
25 on the teats of the cow. This position is stored for the milking animal in question in a memory of a computer.

When the animal in question has to be milked again it is confined in the same way, and the teat cups move mechanically back to the positions for teat distances for that animal stored earlier in the  
30 memory.

It has been found that this method gives a satisfactory result in on average 95% of cases.

However, problems arise if the teats of the animals are not in the same position on a subsequent visit. In such a case manual  
35 readjustment is necessary, and this readjustment can act as the new basic setting for the animal in question.

Such a shift in the position of the teats occurs in particular in the case of young animals, in which the size of the udder increases

with growth, which gives rise to greater distances between teats.

In the case of adult animals it has been found that fluctuating milk yield occurs per visit to the milking robot thus designed. Due to the fact that the milk yield varies, the teat position per milking animal  
5 will constantly vary through greater or lesser tension of the udder through the fluctuating quantity of milk present therein.

Besides, during the period between two calvings the milk yield increases during the first months and decreases again afterwards. This will also lead to a change in the distances between teats.

10 In practice, this means that it is not possible to make a milking robot designed in this way operate independently.

The object of the present invention is to provide a method by which the actual teat position is constantly checked, and on the basis of which the teat cups are positioned.

15 This object is achieved by a method for positioning teat cups relative to the teats of an animal, such as a cow, comprising:

- recording the first position of the teats a first time;
- storing said position in a memory as the first position of the teat cups;
- 20 - determining the second position of the teats with said camera a subsequent time;
- determining the deviation of said second position relative to said first position; and
- making a correction, corresponding to said deviation, in the  
25 position of the teat cups.

This means that the position of the teats is set and stored in the memory of a computer only the first time. Thereafter, only corrections are made and are always stored. For the results of the first position-finding are always used as the initial position for the  
30 subsequent position-finding. It goes without saying that the position for each animal is different. As indicated above, in 95% of cases no change in the position will have occurred between two successive milking operations, so that no correction is necessary and the picture of the teats observed by the camera corresponds to the picture previously taken.  
35 This means that the teat cups can be placed relatively quickly on the teats.

This contrasts with systems according to the prior art, in which the position of the teats is constantly redetermined entirely using cameras and ultrasonic devices and the like. Such a method is described

in, for example, the article entitled "De melkrobot komt eraan" (The milking robot is on the way) in Boerderij/Veehouderij 69 (1984), No. 25, p. 18 et seq. of Ing.W./Rossing.

5 The position of the teats can be determined in all ways known in the prior art, for example by means of one or more cameras in one or more planes. In view of the possible changes in the teat position, it is preferable for the position for determining the teats to comprise determining the three-dimensional position thereof.

10 As indicated above, it is possible to work with one or more cameras, but a particularly simple and effective embodiment makes use of a single camera which takes a picture in various height positions.

15 Recording the position of the teats with the camera for the first time can be carried out completely by said camera. In order to speed up and simplify the process, it is possible to record an initial position by placing the teat cups by hand on the ends of the teats and storing the position of the teat cups. On a subsequent occasion this initial position, which is also stored by means of the camera in the manner described above, can be used as the basis.

20 Due to the fact that it is working with an initial position, the camera need only have a relatively small picture area. This means that very great accuracy in the positioning of the teat cups can be obtained by relatively simple means.

25 The invention also relates to a device for fitting teat cups on the teats of a milking animal, such as a cow, comprising a confining device for the animal, teat cups disposed in such a way that they are mechanically movable, and control means for said teat cups. According to the invention, such a device is characterized in that observation means which observe the position of the teat ends of the animal are present, and also memory storage means which store said position in a memory.

30 Comparison means compare the position observed during a subsequent milking operation with said position stored earlier and are connected to correction means which convert the differences between the observed positions into a control signal which is fed to the above-described control means for the teat cups.

35 It is stated above that the observations means preferably comprise camera means.

The invention will be explained in greater detail below with reference to an exemplary embodiment illustrated in the drawing, in which:

Fig. 1 shows in perspective view a part of a milking robot provided with the camera according to the invention;

Fig. 2 shows in side view a part according to Fig. 1 with the camera in high position; and

5 Fig. 3 shows the device shown in Fig. 2 with the camera in low position.

The cluster of teat cups shown in Fig. 1 corresponds essentially to the device shown and described in Figures 1 and 2 of European Patent Application 9220183.4. Therefore express reference is  
10 made to said European Patent Application for the operation thereof. It must be understood that the device according to the invention can be combined with other clusters, for example as shown in Figures 3 and 4 of the same European Application.

It will be understood that Fig. 1 shows only half of a milking  
15 robot, provided with only two teat cups. Fig. 1 shows two bearing arms, i.e. the bottom bearing arm 1 and the top bearing arm 2, which bear the respective teat cups 3, 4 for the right teats of an animal to be milked. Said bearing arms 1, 2 are supported in a subframe which is indicated in its entirety by 5. Said subframe forms part of the whole frame 6, in  
20 which a subframe is also accommodated for supporting the bearing arms with respective teat cups for the right teats of the animal. Since said bearing arms are mirror-symmetrically identical, i.e. left arm 1 is identical to the right arm (not shown), and left arm 2 is identical to the right arm (not shown), in the description which follows attention  
25 will be paid in particular to the left arms 1 and 2, but the description thereof also applies directly to the opposite arms.

The bearing arm 1 consists of telescopic parts 12, 13, the bearing arm 2 of telescopic parts 14, 15. A support 16 is fitted at the end of the outer telescopic part 13. The gimbal ring 17 for the teat cup  
30 4 is fixed at the end of the outer telescopic part 15.

The inner telescopic part 12 is connected to a sliding bush 19, which can be slid up and down about shaft 20. Shaft 20 has one or more keyways 21 (one is shown, but there can be, for example, three). A key 22, which is fixed to the bush 19, projects into the keyway or each  
35 keyway 21. Bush 19 is thus non-rotatable relative to the shaft 20.

The shaft 20 is connected to a drive motor 24 by means of a transmission (likewise not shown), for example a set of gears which are situated in housing 23. Shaft 20 can be rotated, preferably through 9°, by means of said drive motor 24. This rotation of the shaft 20 is



associated with a horizontal movement in the transverse direction of the corresponding teat cup 3.

An extension arm 25 is fixed to the bush 19, to which arm the housing 26 of a piston-cylinder unit, indicated in its entirety by 27, is fixed. The piston rod 28 thereof is fixed to extension arm 29, which in turn is fixed to shaft 20. A vertical movement of the bearing arm 1, and thus of the corresponding teat cup 3, can be produced by means of said piston-cylinder unit 27.

Finally, a drive (not visible in this figure) is accommodated in the drive arm 1, for sliding the outer telescopic part 13 in the lengthwise direction relative to the inner telescopic part 12. The milk lines and the pneumatic lines, which are connected to the teat cup 3, are also not shown in any further detail. They can be guided away by means of the telescopic parts 12, 13. They can be accommodated in said parts, but they can also be guided along the outside thereof.

The drive for the top bearing arm 2 is identical to that of the bottom bearing arm 1. It also has a bush 30, shaft 31, a key 32 connected to the bush 30, and a keyway 33 interacting with said key 32 in shaft 31. The rotary drive of shaft 30 is provided by means of drive motor 34 and transmission 35. The vertical movement of the bearing arm 2 is supplied by the piston-cylinder unit 36, comprising a cylinder 37 and piston rod 39. These are fixed to extension arm 39, 40 respectively.

Fitted on frame 6 is an arm 8, on the end of which a vertical guide 10 is disposed, along which guide a camera 9 can move in a vertically adjustable manner.

A number of recorders (not shown in more detail) are present, by means of which the position of the teat cups relative to the bearing frame is determined. This relates not only to the angular displacement, but also to the height adjustment and degree of extension of telescopic parts 12, 13. These data are stored by way of lines 50 in memory 45. Memory 45 is connected by means of control means 46 which control the various drives of the device described above. In other words, if the teat cups are placed in a certain arbitrary position and this position is stored in memory 45, this position can always be found again by passing on what is stored in memory 45 to control means 46.

Height sensor means 47, connected to memory means 48, are also present. Said memory means are also connected to camera 9. Camera 9 is equipped so that it can scan a very small area in a very sensitive way. The teats can be recognized by the camera by providing lighting by means

of which the teat contour is made as clear as possible, for example by providing a number of narrow light beams. Such lighting may be present on each of the teat cups if desired. Memory 48 is connected to comparison means 49, which are also connected to memory 45.

- 5           A first, highest position of the camera is shown in Fig. 2, and a second, lowest position is shown in Fig. 3.

The device described above works as follows.

- 10           An animal which is to be milked for the first time with the device according to the invention is fixed in position in a manner not shown in any further detail. The teat cups are then moved by hand to the teats of the udder and fixed thereon. Said position is recorded in memory 45. The position of the teats is also observed in this case by the camera in two planes by moving the camera 9 into a highest and a lowest position, and these two positions are stored in memory 48. The height of  
15           the positions is determined by the sensor means 47.

- If the animal is to be milked again, it is fixed in the same position as far as possible in the device in the manner described above. A picture of the teats is then made using camera 9 in the high and low position. These two pictures are compared in comparison means 49 with the  
20           earlier pictures of the teats stored in the memory. If a deviation is found, such a correction is then made using a particular pattern that the teats according to the new, corrected picture come to lie exactly on the teats of the first picture. During this correction there is also a correction of the position of the teat cups in memory 45. If the  
25           positions of the first and last pictures taken correspond exactly, i.e. in fact a correction is made to the picture originally taken, the control means 46 are activated by memory 45 and placed in the correct position on the teats. Using the observation of the camera in its high and low position, or by means of various cameras, it is also possible constantly  
30           to determine the position of the teats and to record and compare this single position.

- Although it has been indicated above that the initial position is determined by positioning the teat cups by hand, it must be understood that all other methods known in the prior art can be used for this, such  
35           as working with ultrasonic waves, cameras etc. Furthermore, the method described above can be used for all clusters of teat cups known in the prior art. These and other modifications are considered obvious for the person skilled in the art, and lie within the scope of the appended claims.



Claims

1. Method for positioning teat cups relative to the teats of a milking animal, such as a cow, comprising:
  - recording the first position of the teats a first time;
  - 5 - storing said position in a memory as the first position of the teat cups;
  - determining the second position of the teats with said camera a subsequent time;
  - determining the deviation of said second position relative to
  - 10 said first position; and
  - making a correction, corresponding to said deviation, in the position of the teat cups.
2. Method according to Claim 1, in which determining said position of the teats comprises determining the three-dimensional position
- 15 thereof.
3. Method according to Claim 2, in which determining said position comprises taking a picture in various height positions.
4. Method according to one of the preceding claims, in which recording the position of the teats for the first time comprises
- 20 recording an initial position of said teats and when subsequently determining the second position of the teats taking said initial position as the basis.
5. Method according to Claim 4, in which recording the initial position comprises fitting the teat cups by hand.
- 25 6. Method according to one of the preceding claims, in which the position of the teats is observed by a camera.
7. Device for fitting teat cups (3) on the teats of a milking animal, such as a cow, comprising a confining device for the animal, teat cups disposed in such a way that they are mechanically movable, and
- 30 control means (45) for said teat cups, characterized in that observation means (9) which observe the position of the teats of the animal are present, and also memory storage means (48) which store said position in a memory, comparison means (49) which compare various positions observed, and correction means which convert the differences between observed
- 35 positions into a control signal which is fed to the control means (46).
8. Device according to Claim 7, in which said observation means comprise camera means (9).
9. Device according to one of Claims 7 or 8, in which main

adjustment means are present, comprising a memory store with the position of the teats of said animal connected to the control means for said teat cups.

10. Device according to one of Claims 7 - 9, comprising lighting  
5 means for lighting the area covered by the camera.

\*\*\*\*\*

fig-1

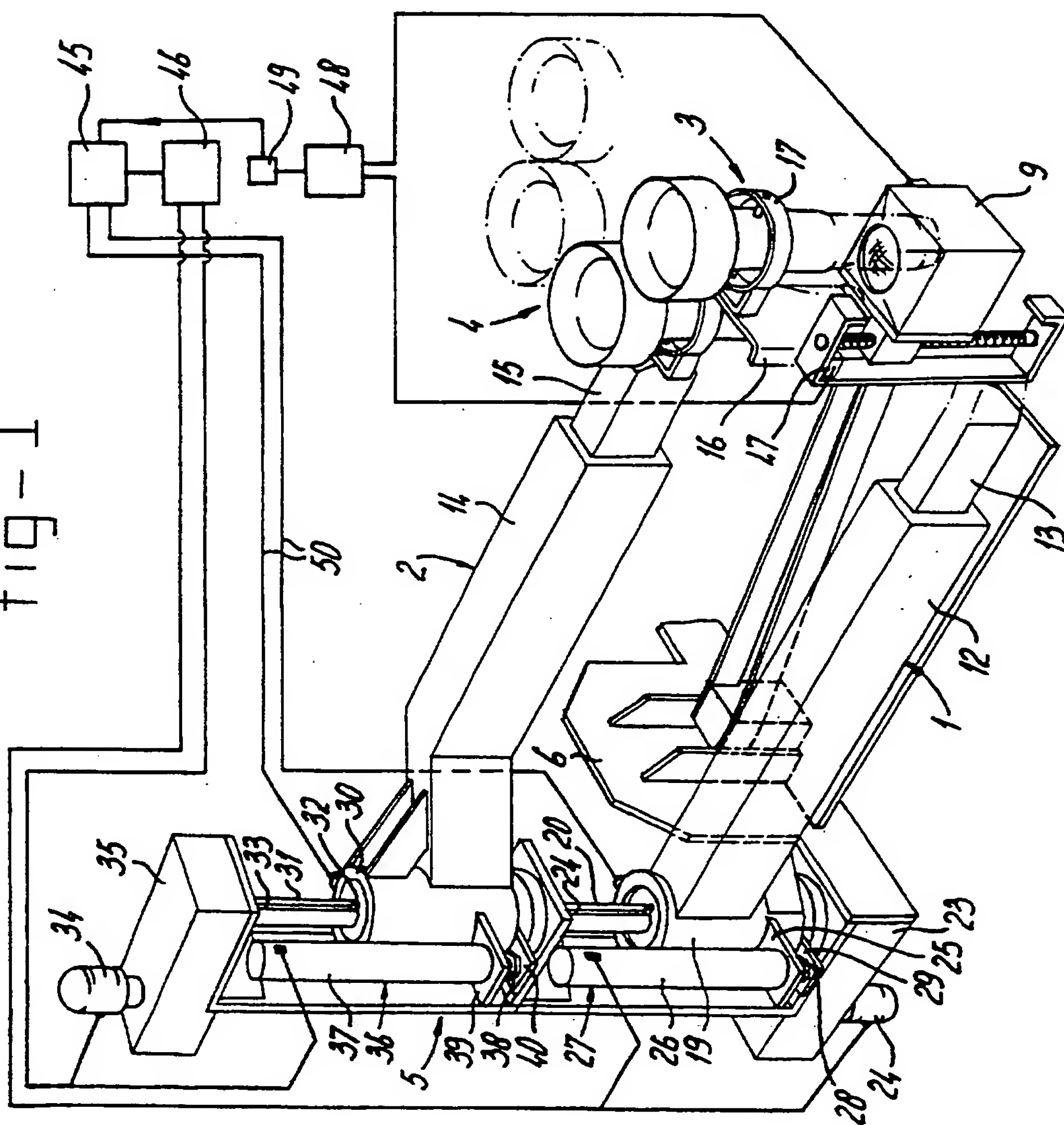


fig - 2

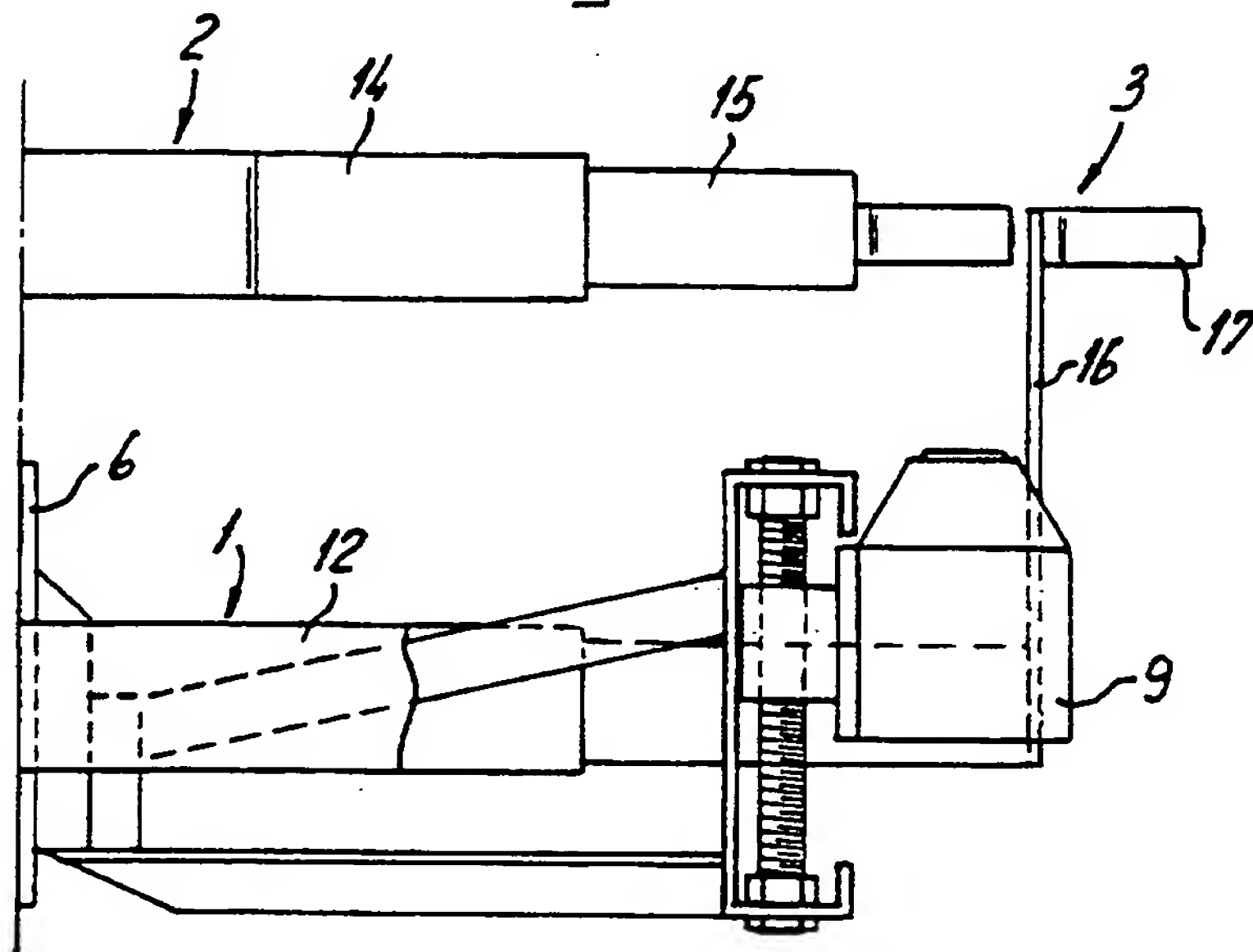
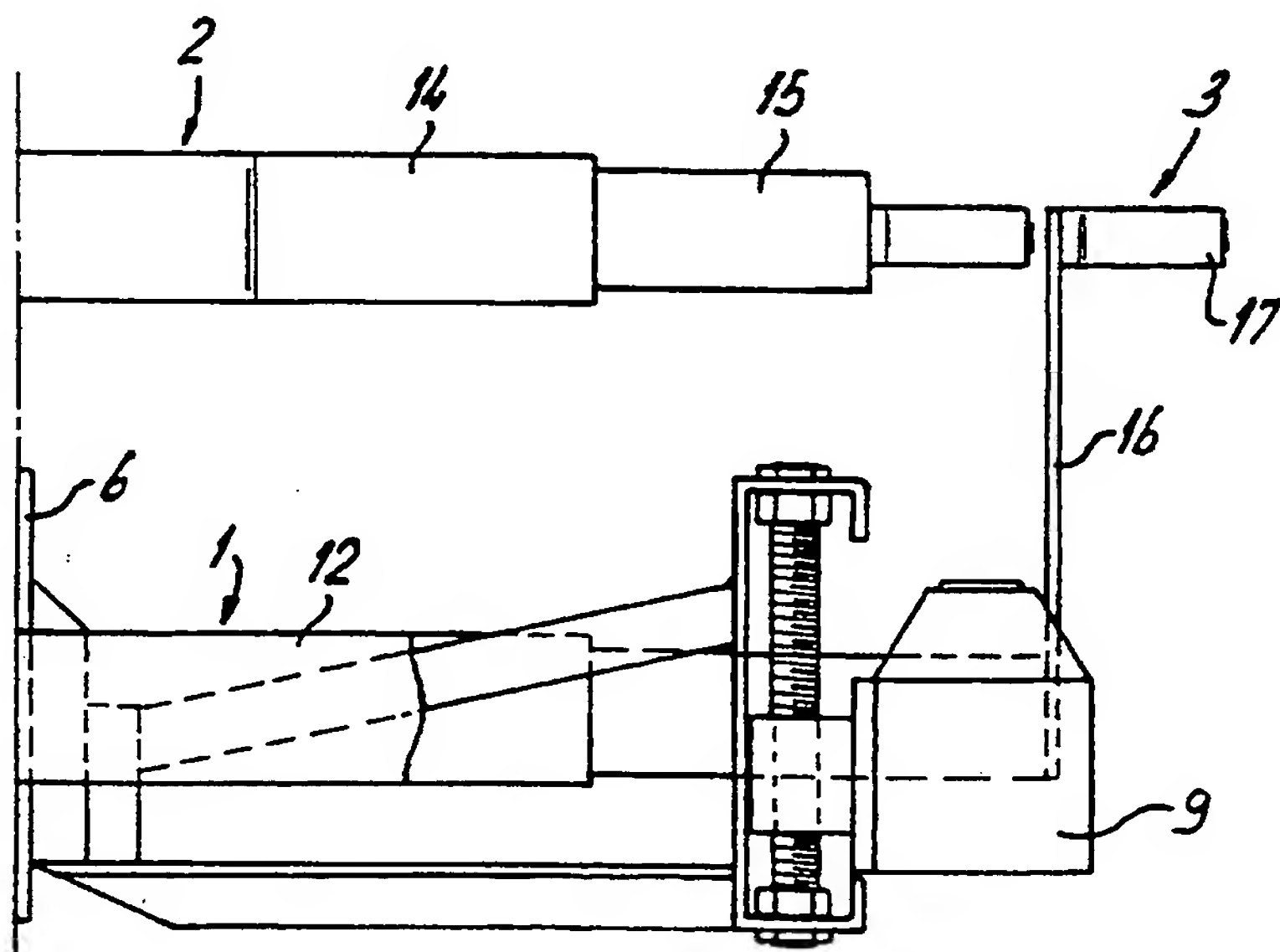


fig - 3



# INTERNATIONAL SEARCH REPORT

Int'l Application No  
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A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 A01J5/017

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 A01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR,A,2 595 197 (CEMAGREF) 11 September 1987 see page 4, line 16 - page 5, line 25 see page 6, line 14 - page 8, line 19 see page 10, line 6 - page 12, line 9 see page 12, line 35 - page 13, line 12 see page 14, line 11 - page 15, line 20 see claims 1-7; figures ---	1-4,6-9
X	EP,A,0 349 019 (VAN DER LELY) 3 January 1990 see column 1, line 22 - line 41 see column 4, line 8 - line 17 see claims; figures --- -/--	1-4,6-9

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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X	EP,A,0 232 568 (MULTINORM BV) 19 August 1987	1
A	see column 7, line 23 - column 8, line 22 see claims 1,17,18; figures ---	2-4,6-9
A	EP,A,0 209 202 (NEDAP) 21 January 1987 see page 1, line 14 - page 2, line 8 see claims; figures see page 3, line 3 - line 9 see page 3, line 22 - page 4, line 1 ---	1,7
A	EP,A,0 309 036 (GASCOIGNE-MELOTTÉ BV) 29 March 1989 cited in the application see column 4, line 34 - line 45; claims; figures -----	1

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Information on patent family members

Int. .onal Application No  
PCT/NL 96/00004

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